Remarks

Specification

The specification is objected to as failing to provide proper antecedent basis pursuant to CFR 1.75(d)(1) and MPEP § 608.01(o).

Clarify meaning of "segment."

The specification is amended to clarify the meaning of the term, "segment," and to insure that the meaning is consistent throughout the specification and claims. The term, "segment," is meant to refer to a whole, physical segment. Parts of segments are referred to as partial segments or segment portions. Corresponding mathematical constructs are referred to as geometric segments. To improve consistency, the term, "physical segment," is shortened to "segment" where there is no sacrifice of clarity.

Correctly identify interior angles.

The specification is amended by adding the word, "interior" wherever it was needed in referring to the interior angles between sides of spherical segments.

Also, Fig. 3C is corrected to clearly show that angles 48 and 52 are interior angles of segment 30. These angles are considerably greater than 90 degrees.

Claim Rejections – 35 USC § 112

Claims 4-7 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The examiner states that it is unclear how the length of a component can have a degree value.

Applicant requests reconsideration and withdrawal of this objection. Claims 4-7 set forth dimensional requirements for segments which are portions of a sphere, specifically, spherical quadrilaterals. As the sides of a polygon on a sphere are great circle arcs, their lengths can be expressed either in angular measure or in conventional units of length. It is more convenient in many cases to express arc lengths in radians or degrees because definite numerical values can be given without making reference to the radius of the sphere.

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In spherical trigonometry, it is customary to compute the sides of a triangle in degrees (or radians), and all formulas are presented in such form. For example, the following formula from spherical trigonometry is known as the (spherical) law of sines:

$$\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$$

where a, b, and c are the sides of the triangle, in degrees or radians, and A, B, and C are the angles of the triangle, in the same units. If units of length are required, then for example, the side a in inches is calculated by

$$a(\text{inches}) = a(\text{radians}) \cdot R(\text{inches}).$$

If calculations are for distances on the earth, arcs in degrees can be converted to nautical miles by recalling that one degree of arc (sixty minutes) equals 60 nautical miles.

Additionally, the specification makes reference to widths of segments both in length units and in degrees. This usage is fully explained in the definitions section of the application under the listing, *Width of a segment*, indicating that the width of a spherical segment may be given in degrees.

By way of support, the following references are attached to this amendment:

(1) M. Richardson, *Plane and Spherical Trigonometry*, page 291, highlighted sentence. MacMillan Co. New York 1950.

(2) Daniel Zwillinger, *CRC / Standard Mathematical Tables and Formulae*, par. 4.19.2, pages 369-70 and par. 4.19.2.1, page 370. Chapman & Hall / CRC New York 2003. Note the references to degree measure for both the sides and angles of an oblique spherical triangle, at the top of page 370.

Claim Rejections – 35 USC § 102

Claims 1-3, 14 are amended to define patentably over Tuczek

Claims 1-3, 14 are rejected under 35 U.S.C. 102(b) as being anticipated by Tuczek, U.S. Patent # 6,282,849. Independent claims 1, 14 are amended to define patentably over Tuczek.

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Tuczek shows that a variety of complex structures can be formed by rearranging the faces of certain polyhedra. For example, he shows that the faces and edge elements (displayed in his Fig. 23) of a rhombic enneacontahedron (shown in Fig. 22) can be rearranged to form other polyhedra such as the distorted triacontahedron and half-regular rhombic dodecahedron shown in Fig. 25. The enneacontahedron displayed in Fig. 22 has two groups of identical rhombic faces: 60 wider rhombi and 30 narrower rhombi. (Tuczek calls them lozenges.) (Note that Fig. 23 is actually an exploded view of the upper left portion of Fig. 22.) Thus one can see that Tuczek's plate 72, which the examiner cites, is a rhombus of the wider type.

None of the embodiments of the present application are concerned with rhombic segments, and no practical use of the invention having rhombic segments has been imagined. What the applicant regards as his invention is the creation of segments that are based upon dividing a rhombus into unequal numbers of rows and columns. Having equal rows and columns would result in rhombic segments, which are regarded as having inferior qualities for manufacturing and shipping. Unequal rows and columns provide inherently oblong segments having a generally parallelogram shape, with adjacent sides of differing length.

Independent claim 1 is amended to exclude segments of rhombic form by stating that the segments "each have a generally parallelogram shape with adjacent sides of differing length." Independent claim 1 is thus rendered patentable over Tuczek, who lacks a shell of generally spherical form comprising segments that are of a generally parallelogram shape and having adjacent sides of differing length.

Independent claim 14 is amended to more particularly point out and clearly define what the applicant regards as his invention in this matter, which is a shell comprising oblong segments of uniform width (having been derived by a certain division of a rhombus) where each such segment includes a plurality of polygonal faces. The original wording of claim part 14c is subject to some uncertainty of interpretation, and reads as follows: "said segments comprise a plurality of polygonal faces." By this wording, it is uncertain as to whether the plurality of polygonal faces is contained in one segment or in a collection of segments. Claim part 14c now reads, —each said segment comprises a plurality of polygonal faces—.

The new wording reflects the applicant's true intent and is properly supported by the specification for descriptions of Figs. 8-11B. Specifically, Fig. 8 shows four triangles each in segments 120 and 130 (page 33, middle paragraph). Figure 9 shows eight rhombi included in

segment 140 (page 34, lines 3-6). The segment 150 and two segments 160 of Fig. 10 share a total of 12 hexagons—including both whole and part hexagons, each segment holds its equal share of four (page 34, beginning at line 6). Figs. 11A-11B illustrate a portion of a polyhedral shell of generally spherical form, containing 120 hexagons and 12 pentagons. The polyhedron is constructed from segments each containing two hexagons of equal size and width. The 12 pentagons are formed by one-fifth portions attached to one end of each segment, or alternatively may be inserted as interstitial elements (page 34, beginning near to the bottom).

Applicant observes that all of the illustrated embodiments of Figs.8-11B have an additional distinguishing feature, that of having a substantially uniform width. An additional amendment is added, specifying this feature for a segment comprising polygonal faces.

Applicant's claim 14 as amended now contains the following individual segment features:

(1) are substantially identical

(2) have an oblong form

(3) each comprise a plurality of polygonal faces

(4) have a substantially uniform width

Tuczek does not disclose a shell of generally spherical form which is formed from identical oblong segments having a plurality of faces in each segment and having a substantially uniform width. Amended claim 14 is now patentable over Tuczek.

Claims 18-20 are amended to define patentability over Monson.

Claims 18-20 are rejected under 35 U.S.C. 102(e) as being anticipated by Monson et al., U.S. Publication number US 2002/0078635 A1. Applicant is unable to swear behind Monson's provisional filing date. Independent claims 18 and 20 are amended in the same fashion as claim 1 to more distinctly describe the shape of a segment which applicant regards as the invention. In so doing, claims 18-20 are rendered patentable over Monson.

The amended shape description portion of claim 18 now reads as follows:

(3) said substantially identical shape comprising a generally parallelogram shape with adjacent sides of differing length;

The amended shape description of claim 20 now reads:

—oblong segments of a generally parallelogram shape, said shape having adjacent sides of differing length—

Monson's kite-shaped segments do not have opposite sides substantially parallel as is implied for segments of substantially parallelogram shape, nor are all adjacent sides of differing length. Although Monson states that other shapes may be used, no others are illustrated besides his kite-shaped segments and triangular prior-art examples.

The examiner cites Monson's Fig. 2C as illustrating an oblong form and a uniform width. However, Fig. 2C is a cross-sectional view of a panel and so does not illustrate the shape or width of the panel, as would be seen in plan form such as Fig. 1. Monson implies that the plan view for this figure would be essentially the same as that in Fig. 1, with the section view being taken along section line 2—2.

Applicant presents that amended independent claims 18 and 20 and dependent claim 19 now define patentably over Monson.

Claim Rejections – 35 USC § 103

Claims 4-13, 15 and 17 no longer obvious from Tuczek in view of Novak.

Claims 4-13, 15 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tuczek in view of Novak, U.S. Patent # 3,691,704. Applicant proposes that independent claims 1 and 14 as amended are patentable over Tuczek and, as currently amended, not all of the features of claims 1 and 14 now missing in Tuczek are to be found in Novak. As dependent claims 4-13 depend from independent claim 1, and dependent claims 15-17 depend from independent claim 14, it follows that novelty over Tuczek in view of Novak is provided.

Claims 4-13 argued on the basis of amended claim 1

Applicant's claim 1 as amended contains the following individual segment features:

(1) are identical

(2) have a generally parallelogram shape with adjacent sides differing in length.

In all figures of the present application, adjacent sides differ in length by 50% or more. It would be very disadvantageous to utilize much smaller differences, such as 20% or less. Claim 1 clearly excludes rhombi, which have equal sides all around. Also, kite-shapes, triangles, and trapezoids are excluded. Note that for a parallelogram, if sides differ in length at one corner,

then they necessarily do at all corners. Moderate distortion of the figure does not change this conclusion.

Tuczek does not have feature (2) in any shell of generally spherical form, since he only uses rhombi (Figs. 18, 22, 25, 26,), triangles (Figs. 30, 36, and possibly 37 and 12), or triangles combined with trapezoids (Fig. 14). Novak discloses only kite-shaped spherical quadrilaterals and spherical triangles. Novak is thus able to provide spherical form, overlapping attachment means, spaced-apart shells and certain other features, but lacks the essential feature of a generally parallelogram shape.

Concerning comparisons of elements in claims 4-13 with those in Tuczek, it should be recalled that all of these claims refer to quadrilaterals on the sphere, having a general parallelogram shape (claim 2), as well as referring to segments having sides of differing lengths (amended claim 1). For example, in the spherical quadrilateral segments of claims 4-7 (which subtend a solid angle of $\pi/15$ steradians), the sum of the interior angles is 372 degrees (exactly) as compared to Tuczek's flat rhombic segments whose sum of angles is only 360 degrees. The difference of 12 degrees prevents a close correspondence between angles.

Further, Tuczek does not discuss how his system of flat panels and straight edge bars might be adapted to spherical surfaces, nor does he even suggest this. And, no aspect of Novak's patent would suggest this. There is no basis to expect that a person skilled in the art would seek to combine the elements of Tuczek's flat constructions with the spherical connection concepts of Novak, and if he did, there would be no reason to abandon the similar segment symmetries of Tuczek and Novak for the distinctly oblong segments of the present invention.

Claims 15 and 16 argued on the basis of amended claim 14

Applicant's claim 14 as amended contains the following individual segment features:

(1) are substantially identical

(2) have an oblong form

(3) each comprise a plurality of polygonal faces

(4) have a substantially uniform width

Tuczek does not disclose a shell of generally spherical form which is formed from identical oblong segments having a plurality of faces in each segment and having a substantially uniform width. Neither does Novak suggest any combination of additional

features that would allow one skilled in the art to combine Tuczek and Novak to obtain all of the features listed in claim 14. It may be noted that illustrations can be found in the literature of dome architecture that display suitable rows of faces that could be combined to form oblong segments having a plurality of faces. The prior-art Fig. 4A (top Fig. 4B, mislabeled) of Monson is exemplary, and was first presented by Fuller over 50 years ago. The fact that no one has suggested such a construction with grouped faces of a beneficial nature, until the present time, is evidence that one may not conclude that the combination of features of claim 14 should be obvious to a person skilled in the art.

Therefore, applicant offers that amended independent claim 14 specifies patentably over Tuczek in view of Novak. As claims 15-17 depend from claim 14, it follows that claims 15 and 17 also specify patentably over Tuczek and Novak.

Note that there is a special significance for segments on the sphere that have a subtended angle of $\pi/15$ steradians. This angle is exactly one-60th of the total angle of a sphere. Since 60 is the maximum number of identical quadrilaterals that can used to form a whole sphere, this is the smallest solid angle that such identical segments can have. (See page 4, lines 1-3 of the specification.) This is the size and type of all of the basic embodiments of the present application which are described in Figs. 2A-4B, 8, and 9.

Claim 21 is now patentable over Monson in view of amendments to claim 20.

Claim 21 is rejected under U.S.C. 103(a) as being unpatentable over Monson et al., considering that the joining options presented in claim 21 should be obvious to a person skilled in the art. Claim 21 depends from independent claim 20 which has been rendered patentable over Monson by way of amendment. Claim 21 is therefore also patentable over Monson.

Additional remarks

Applicant was concerned that no threshold quantity of identical segments has been specified in either the specification or the original claims. However, the figures provide some indication of the quantity of identical segments that are found to be characteristic of the invention. Following are estimates of the percentages of shell area composed by claimed identical segments as shown for each of the embodiments illustrated in the figures.

Figs. 2A-3C	100%
Figs. 4A-4C	100%
Figs. 5A-5B	98%
Fig. 6	100%
Fig. 7	100%
Fig. 8	100%
Fig. 9	100%
Fig. 10	66.67%
Figs. 11A-11B	95%
Fig. 12	95% as illustrated. 80% minimum
Fig. 13	100%

The specification states that the interstitial pentagons of Fig.12 can be of any size. However, it would be difficult to imagine a useful structural application for which the pentagons would be larger than 20% of the shell area. Therefore, Fig. 12 may be composed of as little as 80% claimed oblong segments.

An important correction must be applied to the above numbers. The specification states that the combining of mirror image segments within a shell is regarded as being within the scope of the invention. (Mirror image segments are illustrated in Figs. 3A and 3B.) Since the claims only specify one shape of identical oblong segments, the possibility of mirror images reduces the 100% composition of many embodiments to a minimum possible 50% for segments of one chirality. A unique exception is the segments of Figs. 11A and 11B, which may not have distinct mirror images.

Continuing this reasoning, the minimum claimed identical segments of each of the embodiments would be half of the numbers above, obtained when equal amounts of the two mirror-image segments are used, with the exception of Figs. 11A-11B. However, it may not be practical to use mirror image segments with Fig. 10, as that would result in an inventory comprising four different segment shapes. Excluding Figs 10-11B from the calculation, it falls to Fig. 12 to have the least practical percentage of claimed identical segments, at 40%. Thus, it would seem prudent to specify a minimum bound on the percentage of area that is claimed.

This has been incorporated into the independent claims as an additional claim element, most commonly written as follows: —all of said segments combined compose more than 39% of the area of the shell.—